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UNITED STATES PATENT APPLICATION

for

IMPEDANCE MATCHING NETWORK WITH TERMINATION OF SECONDARY
RF FREQUENCIES

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IMPEDANCE MATCHING NETWORK WITH TERMINATION OF SECONDARY RF FREQUENCIES

BACKGROUND OF THE INVENTION

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Field of the Invention

This invention relates generally to apparatus for matching the variable impedance of a load, and more particularly to, apparatus for RF power delivery systems for plasma processes utilized in semiconductor or flat panel display manufacturing.

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Brief Description of the Prior Art

In plasma processing applications such as the manufacture of semiconductors or flat panel displays, RF power generators apply a voltage to a load in a plasma chamber and may operate over a wide range of frequencies. The impedance of a plasma chamber can vary with the frequency of this applied voltage, chamber pressure, gas composition, and the target or substrate material. Consequently, a reactive impedance matching network is typically used to transform the chamber impedance to an ideal load for the RF power generator.

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Multiple frequencies are always present in RF plasma processing systems. These different frequencies can be the result of harmonics of the fundamental operational frequency. In many applications, multiple frequencies can be the result of separate power delivery systems operating on the same tool. Common configurations on commercial plasma processing tools include, but are not limited to, dual frequency systems such as 13.56 MHz-350 kHz, 60 MHz- 2 MHz, and 27.12 MHz- 2 MHz. Due to the presence of different frequencies, it may be necessary to provide additional RF circuitry in components designed primarily to work within one frequency range to effect their termination impedance as seen by a separate frequency. Controlling this termination impedance allows the control or limiting of the voltage and current components of the secondary frequencies within the process plasma. Circuitry intended to terminate secondary frequencies must be designed such that it provides the desired termination impedance to the secondary frequencies without adversely affecting the performance of the component within its primary frequency range of operation.

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It would be desirable if there were provided an impedance matching network that had the capability to set specific termination impedances for different frequencies within RF components on a plasma chamber that gave the operator the advantage of being able to tightly regulate the voltage, current, and power within a process at discrete frequencies without concern for impedance variability induced by other components in the system.

It would also be desirable if the matching network had the capability to suppress any undesirable effects caused by harmonics of the fundamental operational frequency.

SUMMARY OF THE INVENTION

There is provided by this invention the addition of a secondary, reactive, resonant circuit to matching network apparatus that allows tight control and repeatability of its impedance as seen by the network operating at secondary frequencies. This secondary circuit is designed in such a way that it does not cause undesirable interference, through conduction or radiation, with the operation of the match network at its fundamental operating frequency. The reactive, resonant circuit may be fixed or adjustable as required by the frequency application.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates plasma apparatus that incorporates the principles of this invention

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Figure 1 there is shown RF plasma processing apparatus that incorporates the principles of this invention that is generally comprised of an RF power generator 10 that supplies power to a substrate 16 mounted in a plasma chamber 14 in a manner well known to those skilled in the art. The chamber 14 is filled with a gas that ignites into plasma for depositing thin films on or etching material from the substrate 16. The matching network 12 is designed to provide an efficient transfer of power from the RF power generator 10 to the RF plasma load 20 in the chamber by matching the different impedances between the generator 10 and plasma load 20. A secondary termination circuit 18 is added between the output of the RF power generator 10 and the input of the plasma chamber 14 to provide specific

impedance at a frequency or frequencies other than the fundamental operational frequency of the match network. The circuit 18 is generally comprised of parallel capacitors C1 and C2 series connected to an inductor L and a variable capacitor C3. In operation, circuit 18 controls the impedance of the match network 12 designed
5 primarily to operate at the fundamental frequency of the RF power generator 10 as seen by secondary frequencies in the system.

It can readily be seen that there is provided herein a novel and unique implementation of a match network in an RF plasma processing system that utilizes an auxiliary resonant, reactive circuit that allows the control or limiting of the voltage
10 and current components of secondary frequencies within the process plasma.

Although there is illustrated and described specific structure and details of operation, it is clearly understood that the same were merely for purposes of illustration and that changes and modifications may be readily made therein by those skilled in the art without departing from the spirit and the scope of this invention.